CLAIMS

What is claimed is:

1. A method of processing lignocellulose-containing material from xylan-containing biomass comprising pentoses and hexoses to produce ethanol and xylitol, comprising the steps of:

processing lignocellulose-containing material from xylan-containing biomass comprising pentoses and hexoses to produce a processed solution comprising free pentoses and hexoses, said processing comprising hydrolysis and/or partial hydrolysis of said lignocellulose-containing material;

said lignocellulose-containing material comprising at least one lignocellulosic material selected from the group consisting of cellulose and hemicellulose;

said pentose comprising at least one pentose-containing material selected form the group consisting of xylose and arabinose;

said hexose comprising at least one hexose-containing material selected from the group consisting of glucose, galactose, rhamnose and/or mannose, ;

said xylan-containing matter selected from the group consisting of wood, hardwood as alder, aspen, birch, beech, eucalyptus, poplar, willow and maple, softwood as pine and spruce, plants, plant constituents, grains as wheat, barley, rice, rye and oat, particulates of grain as straw, hulls, husks, fiber, stems, shells, corn cobs, corn straw ,corn fiber, nutshells, almond shells, coconut shells, bagasse, cotton seed bran, cotton seed skins, wood chips, sawdust, woodpulp, processed paper, spent sulphite liquor, spent liquor from paper processing, spent liquor from woodpulp processing, sulphite cooking liquor, and liquids derived from any of the preceding;

fermenting said processed solution with microbes to produce a fermented solution comprising fermented ethanol, xylitol and spent microbes, said fermenting comprising converting said hexose in said processed solution to ethanol and converting said pentoses to xylitol or xylitol and ethanol;

said microbes comprising at least one fermenting microorganism selected form the group consisting of naturally occurring bacteria, recombinant bacteria, naturally occurring yeast, recombinant yeast, and fungi; and

distilling fermented liquid derived from said fermented solution to produce distilled ethanol, said distilled ethanol comprising a greater concentration of ethanol by weight on a liquid basis than said ethanol in said fermented solution.

2. A method according to Claim 1 wherein:

said fermented solution comprises fermented xylitol;

said fermenting comprises reducing xylose in said processed solution to fermented xylitol;

said distilling further produces xylitol bottom product comprising distilled xylitol; and

said xylitol bottom product comprises a greater concentration of distilled xylitol by weight on dry substance (solids) basis than said fermented xylitol in said fermented solution.

3. A method according to Claim 2 further comprising:

separating said xylitol bottom product to produce a xylitol product and residue; and

said xylitol product comprises a greater concentration of xylitol by weight on a dry substance (solids) basis than said distilled xylitol in said xylitol bottom product.

4. A method according to Claim 3 wherein:

said separating comprises chromatographic separation; and

said chromatographic separation is selected from the group consisting of batch separation, continuous simulated moving bed separation, and sequential simulated moving bed separation.

5. A method according to Claim 3 wherein:

said separating comprising filtering; and

said filtering is selected from the group consisting of membrane filtration, ultrafiltration, nanofiltration, and microfiltration.

6. A method according to Claim 5 wherein:

said filtering comprises passing said xylitol bottom product through at least one membrane; and

said membrane is selected from the group consisting of a high shear membrane, a vibrating membrane, a rotating membrane, a flat sheet membrane, a tubular membrane, a spiral membrane, a hollow fiber membrane, a neutral charged membrane, an ionic membrane, a cationic membrane, and an anionic membrane.

7. A method according to Claim 3 further comprising crystallizing said xylitol product to produce xylitol crystals.

8. A method according to Claim 7 wherein said crystallization is cooling crystallization.

9. A method according to Claim 7 wherein said xylitol crystals are separated by centrifugation and filtration and washed with water to produce substantially pure crystalline xylitol.

10. A method according to Claim 1 including removing solids from said processed solution.

11. A method according to Claim 1 including:

separating a substantial portion of said spent microbes from said fermented solution prior to distilling to produce said fermented liquid derived from said fermented solution;

said fermented liquid comprising ethanol, and said fermented liquid comprising substantially less spent microbes by weight on a dry substance (solids) basis that said spent microbes in said fermented solution; and

said separating of said substantial portion of said spent microbes from said fermented solution comprising at least one separating method selected from the group consisting of filtration, centrifugation and decanting.

12. A method according to Claim 1 wherein processing of said lignocellulose-containing material comprises at least one of the following: prehydrolysis of said lignocellulose-containing material, steam explosion of said lignocellulose-containing material, enzymatic hydrolysis of said lignocellulose-containing material with enzymes having a cellulolytic and hemicellulolytic activity to hydrolyze said lignocellulose-containing material, acid hydrolysis of said lignocellulose-containing material, chromatographic separation, membrane filtration, ion-exchange purification, precipitation, partial hydrolysis of said lignocellulose-containing material, and extraction of said lignocellulose-containing material.

13. A method according to Claim 1 wherein said processed solution comprises biomass hydrolysates.

14. A method according to Claim 13 wherein said biomass hydrolysates are obtained by a process selected from the group consisting of direct acid hydrolysis of said biomass, enzymatic prehydrolysate obtained by prehydrolysis of said biomass with steam or acetic acid, acid hydrolysis of prehydrolysate obtained by prehydrolysis of said biomass with steam or acetic acid, autohydrolysis using water or steam, and a sulphite pulping process.

15. A method according to Claim 13 wherein said biomass hydrolysates are selected from the group consisting of: spent sulphite pulping liquor, acid spent sulphite liquor, spent liquor from hardwood pulping, spent liquor from softwood pulping before hexoses are removed, spent liquor from softwood pulping after hexoses are removed, spent liquor from digestion of said biomass, spent liquor from hydrolysis of said biomass, spent liquor from solvent-based pulping, spent liquor from phenol based pulping, spent liquor from formic acid based pulping, spent liquor from ethanol-based pulping, mother liquor from

crystallization of xylose, and diluted runoff of xylose crystallization of sulphite spent pulping liquor based fraction/solution.

16. A method according to Claim 1 wherein:
said pentose in said processed solution comprises arabinose; and
said arabinose is reduced to arabinitol during said fermentation.

17. A method according to Claim 1 wherein:
said processing comprises
partially hydrolyzing said lignocellulose-containing material;
separating said partially hydrolyzed lignocellulose-containing material into an extracted biomass comprising hexosans, and a prehydrolyzate comprising free xylose;
hydrolyzing said extracted biomass to produce an hydrolyzate comprising hexoses;
said fermenting comprises
fermenting said hydrolyzate to produce a fermented solution comprising ethanol; and
fermenting said prehydrolyzate to produce a fermented solution comprising xylitol or xylitol and ethanol.

18. A method according to Claim 1 including post processing said processed solution in at least one post processing step selected from the group consisting of: crystallization, purification, chromatography, membrane filtration, ion-exchange, concentration, evaporation, reverse osmosis, color removal, reduction, detoxification, and catalytic hydrogenation.

19. A method according to Claim 1 wherein said processed solution is detoxified to help remove inhibitors prior to fermenting by one or more of the following: liming, calcium hydroxide addition, sodium hydroxide addition, pH adjustment, concentration, filtering, activated charcoal treatment, extraction with organic solvents, ion exchange, ion

exclusion, molecular sieve treatment, steam stripping, heating, removing furfural, stripping volatile compounds, and reducing of said processed solution by sulphite addition.

20. A method according to Claim 1 wherein:

said naturally occurring bacteria is selected from the group consisting of *Bacillus macerans* DMS 1574, *Bacteroides polypragmatus* NRCC 2288, *Clostridium saccharolyticum* ATCC 35040, *C. thermohydrosulfurcium* 39E, *C. thermohydrosulfuricum* ATCC 31925, *Erwinia chrysanthemi* 8374, *Thermoanaerobacter ethanolicus* ATTC 31938, *Lactobacillus brevis*, and *Lacococcus lactis ssp. Lactis*;

said recombinant bacteria is selected from the group consisting of *Erwinia chrysanthemi* 8374, *Escherichia coli* B, *E. coli* B K011, *Klebsiella oxytoca* M5A1, *K. planticola* SDF20, *Zymomonas mobilis CP4*, and *Z. mobilis* NRRL 14023;

said naturally occurring yeast is selected from the group consisting of *Candida blanki* ATCC 18736, *C. acidothermophilum* ATCC 20831, *C. brassicae* ATCC 32196, *C. famata*, *C. fructus* JCM 1513, *C. guilliermondii* ATCC22017, *C. shehatae* CBS 4705, C. *shehatae* CSIR Y492, C. *shehatae* ATCC 22984. *sp* CSIR 62 A/2, *C. tenuis* CBS 4435, *C. tropicalis* KY 5014, *C. tropicalis* ATCC 20240, *C. tropicalis* ATCC 9968, *C. tropicalis* NRRL y 11860, *Clavispora sp.* UWO 83-833-1, *Kluyveromyces cellobiovous* KV 5199, *K. marxianus*, *Pachysolen tannophilus* NRRL Y 2460, *P. tannophilus* RL 171, *Pichia segobiensis* CBS 6857, *P. stipitis* CBS 5773, *P. stipitis* CBS 5776, *P. stipitis* NRRL Y 1714, *Schizosaccharomyces pombe* ATCC 2478, *Hansenula anomala* ATCC 34080, *Kluyveromyces fragilis* ATCC 12424, *Saccharomyces uvarum* ATCC 24556, *S. uvarum* ATCC 26602, *F. oxysporum*, and *Debaryomyces hansenii*;

said recombinant yeast is selected from the group consisting of *Saaccharomyces cerevisiae*, *S. cerevisiae* TJ1, *S. cerevisiae* H550, *S. cerevisiae* ATCC 24860, *Schizosaccharomyces pombe* ATCC 2456, and *S. pombe* NRRL Y164; and

said fungi is selected from the group consisting of *Aureobasidium pullulans*, *Fusarium avenaceium* VTT-D-80146, *F. clamydosporum* VTT-D-77055, *F. culmorum* VTT-D-80148, *F. graminearum* VTT-D-79129, *F. lycopersici* ATCC 15417, *F. oxysporum* VTT-D-80134, *F. sembucium* VTT-D-77056, *F. solani* VTT-D-80139, *Monilia sp.*, *Mucor sp.* 105, *Neurospora crassa* NCIM 870, and *Paecilmyces sp.* NFI ATCC 20766.

21. A method according to Claim 1 wherein said fermenting microorganism is a yeast selected from the group consisting of a yeast of the genera *Candida, Pichia, Pachysolen*, or *Debaryomyces*.

22. A method according to Claim 21 wherein said yeast is selected form the group consisting of genera *Candida tropicalis, Candida tropicalis* ATCC 9968, *Pachysolen tannophilus*, and *Debaryomyces hansenii*.

23. A method according to Claim 22 wherein said fermenting occurs at a temperature ranging from about 10 to about 45 degrees C at a pH ranging from 4 to 7 with a yeast concentration of about 1 to about 40 g of dry yeast per liter of processed solution for about 24 to about 96 hours in the presence of at least one nutrient.

24. A method according to Claim 23 wherein said nutrient is selected from the group consisting of yeast extract, diammoniumphosphate, peptone, biotin, thiamin, folic acid, a water soluble vitamin, a fat soluble vitamin, vitamin A, vitamin B complex, vitamin D, vitamin E, vitamin K, vitamin B1, vitamin B2, vitamin B5, vitamin B6, vitamin B12, vitamin B15, and a vitamin.

25. A method according to Claim 1 including crystallizing said xylitol to produce crystalline xylitol.

26. A method according to Claim 1 wherein said xylitol comprises liquid xylitol.

27. A method of processing lignocellulose-containing material from xylan-containing biomass comprising pentoses and hexoses to produce ethanol and xylitol, comprising the steps of:

hydrolyzing lignocellulose-containing material from xylan-containing biomass comprising pentoses and hexoses to produce a hydrolyzed solution comprising free pentoses and hexoses;

said lignocellulose-containing material comprising at least one lignocellulosic material selected from the group consisting of cellulose, hemicellulose,

said pentose comprising at least one pentose-containing material selected form the group consisting of xylose and arabinose;

said hexose comprising at least one hexose-containing material selected from the group consisting of glucose, galactose, rhamnose, mannose, and other monosaccharides;

said xylan-containing matter selected from the group consisting of wood, hardwood as alder, aspen, birch, beech, maple, eucalyptus, willow, and poplar, softwood as pine and spruce, plants, plant constituents, grain as wheat, barley, rice, rye and oat particulates of grains as straw, hulls, husks, stems, fiber, shells , corn cobs, corn stems, corn fibres, nutshells, almond shells, coconut shells, bagasse, cotton seed bran, cotton seed skins, wood chips, sawdust, woodpulp, processed paper, spent sulphite liquor, spent liquor from hardwood pulping, spent liquor from paper processing, spent liquor from woodpulp processing, sulphite cooking liquor, and liquids derived from any of the preceding;

fermenting said hydrolyzed solution with microbes to produce a fermented solution comprising fermented ethanol, fermented xylitol, fermented xylose, and spent microbes, said fermenting comprising converting a substantial amount of said hexose in said hydrolyzed solution to fermented ethanol and reducing a substantial amount of said pentose in said hydrolyzed solution to fermented xylitol, fermented ethanol solution and fermented xylose;

said microbes comprising at least one fermenting microorganism selected form the group consisting of naturally occurring bacteria, recombinant bacteria, naturally occurring yeast, recombinant yeast, and fungi; and

distilling fermented liquid derived from said fermented solution to produce distilled ethanol and a distilled solution comprising distilled xylitol solution, distilled xylose and spent microbes, said distilled ethanol comprising a greater concentration of distilled ethanol by weight on a liquid basis than said fermented ethanol in said fermented solution, said distilled solution having a greater concentration of distilled xylitol solution by weight on a dry substance (solids) basis than said fermented xylitol solution in said fermented solution; and

separating said distilled solution by fractionating said distilled solution into fractions comprising a separated xylitol-producing fraction and a separated xylose fraction, said separated xylitol-producing fraction comprising a greater concentration of xylitol-producing solution by weight on a dry substance (solids) basis than said distilled xylitol-producing solution in said distilled solution.

28. A method according to Claim 27 including crystallizing said xylitol to produce crystalline xylitol.

29. A method according to Claim 27 wherein said xylitol comprises liquid xylitol.

30. A method according to Claim 27 wherein:

said hydrolyzed solution is subjected to at least one treatment selected from the group consisting of: pH adjustment, concentration, filtration, filtering with a pressure filter, filtering with diatomaceous earth, chromatographic separation, detoxification, removing inhibitors, overliming, calcium hydroxide addition, sodium hydroxide addition, activated charcoal, extraction with organic solvents, ion exchange, ion exclusion, molecular sieves, steam stripping, heating, removing furfural, stripping volatile compounds, and reduction of said hydrolyzed solution by sulphite addition;.

said xylitol solution selected from the group consisting of a xylitol-rich solution and a xylose-rich solution;

said xylitol solution having a greater concentration of at least one compound on a dry substance (solids) basis than said compound in said hydrolyzed solution; and

said compound is selected from the group consisting of xylitol, xylose, arabinose, mannose, and galactose and rhamnose.

31. A method according to Claim 30 wherein:

said separating comprises chromatographic separation; and

said chromatographic separation is selected from the group consisting of batch separation, continuous simulated moving bed separation, and sequential simulated moving bed separation.

32. A method according to Claim 30 wherein:

said separating comprising filtering; and

said filtering is selected from the group consisting of membrane filtration, ultrafiltration, nanofiltration, and microfiltration.

33. A method according to Claim 32 wherein:

said filtering comprises passing said distilled solution through at least one membrane; and

said membrane is selected from the group consisting of a high shear membrane, a vibrating membrane, a rotating membrane, a flat sheet membrane, a tubular membrane, a spiral membrane, a hollow fiber membrane, a neutral charged membrane, an ionic membrane, a cationic membrane, and an anionic membrane.

34. A method according to Claim 27 further comprising crystallizing said xylitol fraction to produce xylitol crystals.

35. A method according to Claim 34 wherein said crystallization is selected from the group consisting of cooling crystallization.

36. A method according to Claim 35 wherein said xylitol crystals are separated by centrifugation or filtration and washed with water to produce substantially pure crystalline xylitol.

37. A method according to Claim 27 including hydrogenating said separated xylose fraction to produce hydrogenated xylitol.

38. A method according to Claim 37 further comprising crystallizing said hydrogenated xylitol to produce xylitol crystals.

39. A method according to Claim 27 including:

separating a substantial portion of said spent microbes from said fermented solution prior to said distilling to produce said fermented liquid derived from said fermented solution;

said fermented liquid comprising fermented ethanol, fermented xylitol, fermented xylose, and spent microbes;

said fermented liquid comprising substantially less spent microbes by weight on a dry substance (solids) basis that said spent microbes in said fermented solution; and

said separating of said substantial portion of said spent microbes from said fermented solution comprising at least one separating method selected from the group consisting of filtration, centrifugation, and decanting.

40. A method according to Claim 27 including removing a substantial amount of solids from said hydrolyzed solution before fermenting, said removing comprising at least one removal step selected from the group consisting of filtration, centrifugation and decanting.

41. A method according to Claim 27 wherein said hydrolyzing is selected from the group consisting of: enzymatic hydrolysis of said lignocellulose-containing material with enzymes having a cellulolytic and xylanolytic activity to hydrolyze said lignocellulose-containing material, and acid hydrolysis of said lignocellulose-containing material.

42. A method according to Claim 27 including pretreatment of said lignocellulose-containing material before said hydrolyzing, said pretreatment comprising at least one pretreatment method selected from the group consisting of prehydrolysis of said lignocellulose-containing material, steam explosion of said lignocellulose-containing material, alkaline treatment, solvent extraction, partial hydrolysis of said lignocellulose-containing material, and extraction by alkali, NaOH, NH4OH of said lignocellulose-containing material.

43. A method according to Claim 27 wherein said hydrolyzed solution comprises biomass hydrolysates.

44. A method according to Claim 43 wherein said biomass hydrolysates are obtained by a process selected from the group consisting of direct acid hydrolysis of said biomass, enzymatic prehydrolysate obtained by prehydrolysis of said biomass with steam or acetic acid; acid hydrolysis of prehydrolysate obtained by prehydrolysis of said biomass with steam or acetic acid, a sa-prehydrolysis process, autohydrolysis using water or steam, and a sulphite pulping process.

45. A method according to Claim 43 wherein said biomass hydrolysates are selected from the group consisting of: spent sulphite pulping liquor, acid spent sulphite liquor, spent liquor from hardwood pulping, spent liquor from softwood pulping before hexoses are removed, spent liquor from softwood pulping after hexoses are removed, spent liquor from digestion of said biomass, spent liquor from hydrolysis of said biomass, spent liquor from solvent-based pulping, spent liquor from phenol based pulping, spent liquor from formic acid based pulping, spent liquor from ethanol-based pulping, mother liquor from crystallization of xylose, and diluted runoff of xylose crystallization of sulphite spent pulping liquor based liquor

46. A method according to Claim 27 wherein:
said pentose in said processed solution comprises arabinose; and
said arabinose is reduced to arabinitol during said fermentation.

47. A method according to Claim 27 wherein:

said naturally occurring bacteria is selected from the group consisting of *Bacillus macerans* DMS 1574, *Bacteroides polypragmatus* NRCC 2288, *Clostridium saccharolyticum* ATCC 35040, *C. thermohydrosulfuricum* 39E, *C. thermohydrosulfuricum* ATCC 31925, *Erwinia chrysanthemi* 8374, *Thermoanaerobacter ethanolicus* ATTC 31938, *Lactobacillus brevis*, and *Lacococcus lactis ssp. Lactis*;

said recombinant bacteria is selected from the group consisting of *Erwinia chrysanthemi* 8374, *Escherichia coli* B, *E. coli* B K011, *Klebsiella oxytoca* M5A1, *K. planticola* SDF20, *Zymomonas mobilis CP4*, and *Z. mobilis* NRRL 14023;

said naturally occurring yeast is selected from the group consisting of *Candida blanki* ATCC 18736, *C. acidothermophilum* ATCC 20831, *C. brassicae* ATCC 32196, *C. famata, C. fructus* JCM 1513, *C. guilliermondii* ATCC22017, *C. shehatae* CBS 4705, C. *shehatae* CSIR Y492, C. *shehatae* ATCC 22984. *sp* CSIR 62 A/2, *C. tenuis* CBS 4435, *C. tropicalis* KY 5014, *C. tropicalis* ATCC 20240, *C. tropicalis* ATCC 9968, *C. tropicalis* NRRL y 11860, *Clavispora sp.* UWO 83-833-1, *Kluyveromyces cellobiovous* KV 5199, *K. marxianus, Pachysolen tannophilus* NRRL Y 2460, *P. tannophilus* RL 171, *Pichia segobiensis* CBS 6857, *P. stipitis* CBS 5773, *P. stipitis* CBS 5776, *P. stipitis* NRRL Y 1714, *Schizosaccharomyces pombe* ATCC 2478, *Hansenula anomala* ATCC 34080, *Kluyveromyces fragilis* ATCC 12424, *Saccharomyces uvarum* ATCC 24556, *S. uvarum* ATCC 26602, *F. oxysporum*, and *Debaryomyces hansenii*;

said recombinant yeast is selected from the group consisting of *Saaccharomyces cerevisiae, S. cerevisiae* TJ1, *S. cerevisiae* H550, *S. cerevisiae* ATCC 24860, *Schizosaccharomyces pombe* ATCC 2456, and *S. pombe* NRRL Y164; and

said fungi is selected from the group consisting of *Aureobasidium pullulans, Fusarium avenaceium* VTT-D-80146, *F. clamydosporum* VTT-D-77055, *F. culmorum* VTT-D-80148, *F. graminearum* VTT-D-79129, *F. lycopersici* ATCC 15417, *F. oxysporum* VTT-D-80134, *F. sembucium* VTT-D-77056, *F. solani* VTT-D-80139, *Monilia sp., Mucor sp.* 105, *Neurospora crassa* NCIM 870, and *Paecilmyces sp.* NFI ATCC 20766.

48. A method according to Claim 27 wherein said fermenting microorganism is a yeast selected from the group consisting of a yeast of the genera *Candida, Pichia, Pachysolen*, or *Debaryomyces*.

49. A method according to Claim 48 wherein said yeast is selected form the group consisting of genera *Candida tropicalis, Candida tropicalis* ATCC 9968, *Pachysolen tannophilus*, and *Debaryomyces hansenii*.

50. A method according to Claim 49 wherein said fermenting occurs at a temperature ranging from about 10 to about 45 degrees C at a pH ranging from 4 to 7 with a

yeast concentration of about 1 to about 40 g of dry yeast per liter of hydrolyzed solution for about 24 to about 96 hours in the presence of at least one nutrient.

51. A method according to Claim 49 wherein said nutrient is selected from the group consisting of yeast extract, diammoniumphosphate, peptone, biotin, thiamin, folic acid, a water soluble vitamin, a fat soluble vitamin, vitamin A, vitamin B complex, vitamin D, vitamin E, vitamin K, vitamin B1, vitamin B2, vitamin B5, vitamin B6, vitamin B12, vitamin B15, and a vitamin.

52. A method of processing lignocellulose-containing material from xylan-containing biomass comprising pentoses and hexoses to produce ethanol and xylitol, comprising the steps of:

partially hydrolyzing lignocellulose-containing material from xylan-containing matter in biomass comprising pentoses and hexoses to produce a partially hydrolyzed solution comprising free pentoses and hexoses, pentosans, and hexosans;

said lignocellulose-containing material comprising at least one lignocellulosic material selected from the group consisting of cellulose, hemicellulose;

said pentoses comprising at least one pentose-containing material selected form the group consisting of xylose and arabinose;

said hexoses comprising at least one hexose-containing material selected from the group consisting of glucose, galactose, rhamnose and mannose;

said xylan-containing matter selected from the group consisting of wood, , hardwood as alder, aspen, birch, beech, eucalyptus, poplar, willow and maple, softwood as pine and spruce, willow, plants, plant constituents, grains as wheat, barley, rye, rice and oat particulates of grain as straw, hulls, husks, fiber, stems, shells, corn cobs, cornstraw, corn fiber, nutshells, almond shells, coconut shells, bagasse, cotton seed bran, cotton seed skins, wood chips, sawdust, woodpulp, processed paper, spent sulphite liquor, spent liquor from hardwood pulping, spent liquor from paper processing, spent liquor from woodpulp processing, sulphite cooking liquor, and liquids derived from any of the preceding;

separating said partially hydrolyzed solution into an extracted biomass and solubles, said extracted mass comprising pentosans and hexosans, and solids, said solubles comprising xylose, soluble xylans, pentoses, soluble pentosans and residue;

hydrolyzing said extracted biomass to produce a hydrolyzed biomass comprising hydrolyzed hexoses, hydrolyzed pentoses, and hydrolyzed solids, said hydrolyzing converting a substantial amount of said pentosans to pentoses, and said hydrolyzing converting a substantial amount of said hexosans to hexoses;

separating said hydrolyzed biomass into a separated biomass solution and solids, said separated biomass solution comprising pentoses and hexoses, said separated biomass solution comprising a greater concentration of pentoses by weight on a dry substance (solids) basis than said hydrolyzed pentoses in said hydrolyzed biomass, said separated biomass solution comprising a greater concentration of hexoses by weight on a dry substance (solids) basis than said hydrolyzed hexoses in said hydrolyzed biomass;

fractionating said solubles to separate said solubles into fractions comprising a xylose-rich fraction, and a residue (residual) fraction, said xylose-rich fraction comprising a higher concentration of xylose by weight on a dry substance (solids) than said xyloses in said solubles, said residue fraction comprising a higher concentration of residue by weight on a dry substance (solids) than said residue in said solubles, said xylose-rich fraction comprising a higher concentration of at least one compound by weight on a dry substance (solids) than said compound in said other fractions, and said compound being selected from the group consisting of xylose, xylitol, arabinose, mannose, and galactose and rhamnose;

hydrogenating said xylose-rich fraction to produce hydrogenated xylitol, said hydrogenated xylitol having a greater concentration of xylitol by weight on a dry substance (solids) basis than said xylitols in said solubles;

fermenting said xylose-containing fraction and said separated biomass solution with microbes to produce a fermented solution comprising fermented ethanol and spent microbes, said fermenting comprising converting a substantial amount of said xyloses in said xylose-containing fraction to fermented ethanol and part to xylitol and reducing a substantial amount of said pentoses and hexoses in said separated biomass solution to fermented ethanol; and

said microbes comprising at least one fermenting microorganism selected form the group consisting of naturally occurring bacteria, recombinant bacteria, naturally occurring yeast, recombinant yeast, and fungi.

53. A method according to Claim 52 including crystallizing said xylitol to produce crystalline xylitol.

54. A method according to Claim 52 wherein said xylitol comprises liquid xylitol.

55. A method according to Claim 52 including distilling fermented liquid derived from said fermented solution to produce a distilled solution comprising distilled ethanol, said distilled ethanol comprising a greater concentration of ethanol by weight on a liquid basis than said fermented ethanol in said fermented solution.

56. A method according to Claim 55 including:

separating a substantial portion of said spent microbes from said fermented solution prior to said distilling and optionally before to said distilling to produce said fermented liquid derived from said fermented solution;

said fermented liquid comprising fermented ethanol and spent microbes;

said fermented liquid comprising substantially less spent microbes by weight on a dry substance (solids) basis that said spent microbes in said fermented solution; and

said separating of said substantial portion of said spent microbes from said fermented solution comprising at least one separating method selected from the group consisting of filtration, centrifugation, decanting, flocculation and flotation

57. A method according to Claim 52 wherein separating of said hydrolyzed biomass includes at least one separation method selected from the group consisting of: filtration of said hydrolyzed biomass, membrane filtration of said hydrolyzed biomass, ultrafiltration of said hydrolyzed biomass, nanofiltration of said hydrolyzed biomass, microfiltration of said hydrolyzed biomass, centrifugation of said hydrolyzed biomass, decanting of said hydrolyzed biomass, clarification of said hydrolyzed biomass,

crystallization of said hydrolyzed biomass, chromatography, ion exclusion, ion-exchange of said hydrolyzed biomass, concentration of said hydrolyzed biomass, evaporation of said hydrolyzed biomass, reverse osmosis of said hydrolyzed biomass, color removal of said hydrolyzed biomass, reduction of said hydrolyzed biomass, detoxification of said hydrolyzed biomass, and catalytic hydrogenation of said hydrolyzed biomass.

58. A method according to Claim 52 wherein said separated biomass solution is detoxified to help remove inhibitors prior to fermenting with one or more of the following: liming, calcium hydroxide or calcium oxide addition, hydroxide addition e.g. NaOH, pH adjustment, activated charcoal treatment, extraction with organic solvents, ion exchange, ion exclusion, molecular sieve treatment, steam stripping, heating, removing furfural, stripping volatile compounds, and reduction of said separated biomass solution by sulphite addition.

59. A method according to Claim 52 wherein said xylose-containing fraction is detoxified to help remove inhibitors prior to fermenting by one or more of the following: liming, calcium hydroxide or calcium oxide addition, hydroxide addition e.g. NaOH, pH adjustment, concentration, filtering, activated charcoal treatment, extraction with organic solvents, ion exchange, ion exclusion, molecular sieve treatment, steam stripping, heating, removing furfural, stripping volatile compounds, and reduction of said xylose-containing fraction by sulphite addition.

60. A method according to Claim 52 including combusting at least some of said solids in said extracted biomass prior to hydrolyzing said extracted biomass.

61. A method according to Claim 52 wherein:

said fractionating comprises chromatographic separation; and

said chromatographic separation is selected from the group consisting of batch separation, continuous simulated moving bed separation, and sequential simulated moving bed separation.

62. A method according to Claim 52 wherein:

said fractionating comprising filtering; and

said filtering is selected from the group consisting of membrane filtration, ultrafiltration, nanofiltration, and microfiltration.

63. A method according to Claim 62 wherein:

said filtering comprises passing a solution comprising said solubles through at least one membrane; and

said membrane is selected from the group consisting of a high shear membrane, a vibrating membrane, a rotating membrane, a flat sheet membrane, a tubular membrane, a spiral membrane, a hollow fiber membrane, a neutral charged membrane, an ionic membrane, a cationic membrane, and an anionic membrane.

64. A method according to Claim 52 wherein said hydrogenating comprises chemical hydrogenation.

65. A method according to Claim 52 wherein said hydrogenating comprises biochemical hydrogenation.

66. A method according to Claim 52 further comprising crystallizing said hydrogenated fraction to produce xylitol crystals.

67. A method according to Claim 66 wherein said crystallization is cooling crystallization

68. A method according to Claim 66 wherein said xylitol crystals are separated by centrifugation or filtration and washed with water to produce substantially pure crystalline xylitol.

69. A method according to Claim 52 wherein said hydrolyzing is selected from the group consisting of: enzymatic hydrolysis of said extracted biomass with enzymes having

a cellulolytic and xylanolytic activity to hydrolyze said extracted biomass, and acid hydrolysis of said extracted biomass.

70. A method according to Claim 52 wherein said partially hydrolyzing of said lignocellulose-containing material is selected from the group consisting of: steam explosion of said lignocellulose-containing material, partial enzymatic hydrolysis of said lignocellulose-containing material with enzymes having a cellulolytic and xylanolytic activity to partially hydrolyze said lignocellulose-containing material, partial acid hydrolysis of said lignocellulose-containing material, and subjecting said lignocellulose-containing material to acetic acid.

71. A method according to Claim 52 wherein said partially hydrolyzed solution is separated by at least one separation method selected form the group consisting of: centrifugation of said partially hydrolyzed solution, decanting of said partially hydrolyzed solution, clarification of said partially hydrolyzed solution, crystallization of said partially hydrolyzed solution, chromatography of said partially hydrolyzed solution, ion-exchange, concentration of said partially hydrolyzed solution, evaporation of said partially hydrolyzed solution, reverse osmosis of said partially hydrolyzed solution, catalytic hydrogenation of said partially hydrolyzed solution, filtration of said partially hydrolyzed solution, membrane filtration of said partially hydrolyzed solution, ultrafiltration of said partially hydrolyzed solution, nanofiltration of said partially hydrolyzed solution, and microfiltration of said partially hydrolyzed solution.

72. A method according to Claim 52 wherein said partially hydrolyzed solution comprises biomass hydrolysates.

73. A method according to Claim 72 wherein said biomass hydrolysates are selected from the group consisting of: spent sulphite pulping liquor, acid spent sulphite liquor, spent liquor from softwood pulping before hexoses are removed, spent liquor from softwood pulping after hexoses are removed, spent liquor from hardwood pulping, spent liquor from digestion of said biomass, spent liquor from hydrolysis of said biomass, spent

liquor from sa-prehydrolysis pulping, spent liquor from solvent-based pulping, spent liquor from phenol based pulping, spent liquor from formic acid based pulping, spent liquor from ethanol-based pulping, mother liquor from crystallization of xylose, and diluted runoff of xylitol crystallization of sulphite spent pulping liquor based fraction

74. A method according to Claim 52 wherein:

said pentoses in said separated biomass solution comprises arabinose; and

said arabinose is reduced to arabinitol during said fermentation.

75. A method according to Claim 52 wherein:

said naturally occurring bacteria is selected from the group consisting of *Bacillus macerans* DMS 1574, *Bacteroides polypragmatus* NRCC 2288, *Clostridium saccharolyticum* ATCC 35040, *C. thermohydrosulfuricum* 39E, *C. thermohydrosulfuricum* ATCC 31925, *Erwinia chrysanthemi* 8374, *Thermoanaerobacter ethanolicus* ATTC 31938, *Lactobacillus brevis*, and *Lacococcus lactis ssp. Lactis*;

said recombinant bacteria is selected from the group consisting of *Erwinia chrysanthemi* 8374, *Escherichia coli* B, *E. coli* B K011, *Klebsiella oxytoca* M5A1, *K. planticola* SDF20, *Zymomonas mobilis CP4*, and *Z. mobilis* NRRL 14023;

said naturally occurring yeast is selected from the group consisting of *Candida blanki* ATCC 18736, *C. acidothermophilum* ATCC 20831, *C. brassicae* ATCC 32196, *C. famata*, *C. fructus* JCM 1513, *C. guilliermondii* ATCC22017, *C. shehatae* CBS 4705, C. *shehatae* CSIR Y492, C. *shehatae* ATCC 22984. *sp* CSIR 62 A/2, *C. tenuis* CBS 4435, *C. tropicalis* KY 5014, *C. tropicalis* ATCC 20240, *C. tropicalis* ATCC 9968, *C. tropicalis* NRRL y 11860, *Clavispora sp.* UWO 83-833-1, *Kluyveromyces cellobiovous* KV 5199, *K. marxianus*, *Pachysolen tannophilus* NRRL Y 2460, *P. tannophilus* RL 171, *Pichia segobiensis* CBS 6857, *P. stipitis* CBS 5773, *P. stipitis* CBS 5776, *P. stipitis* NRRL Y 1714, *Schizosaccharomyces pombe* ATCC 2478, *Hansenula anomala* ATCC 34080, *Kluyveromyces fragilis* ATCC 12424, *Saccharomyces uvarum* ATCC 24556, *S. uvarum* ATCC 26602, *F. oxysporum*, and *Debaryomyces hansenii*;

said recombinant yeast is selected from the group consisting of *Saaccharomyces cerevisiae*, *S. cerevisiae* TJ1, *S. cerevisiae* H550, *S. cerevisiae* ATCC 24860, *Schizosaccharomyces pombe* ATCC 2456, and *S. pombe* NRRL Y164; and

said fungi is selected from the group consisting of *Aureobasidium pullulans*, *Fusarium avenaceium* VTT-D-80146, *F. clamydosporum* VTT-D-77055, *F. culmorum* VTT-D-80148, *F. graminearum* VTT-D-79129, *F. lycopersici* ATCC 15417, *F. oxysporum* VTT-D-80134, *F. sembucium* VTT-D-77056, *F. solani* VTT-D-80139, *Monilia sp.*, *Mucor sp.* 105, *Neurospora crassa* NCIM 870, and *Paecilmyces sp.* NFI ATCC 20766.

76. A method according to Claim 52 wherein said fermenting microorganism is a yeast selected from the group consisting of a yeast of the genera *Candida, Pichia, Pachysolen*, or *Debaryomyces*.

77. A method according to Claim 76 wherein said yeast is selected form the group consisting of genera *Candida tropicalis, Candida tropicalis* ATCC 9968, *Pachysolen tannophilus*, and *Debaryomyces hansenii*.

78. A method according to Claim 77 wherein said fermenting occurs at a temperature ranging from about 10 to about 45 degrees C at a pH ranging from 4 to 7 with a yeast concentration of about 1 to about 40 g of dry yeast per liter of solution comprising said xylose-containing fraction and said separated biomass solution, for about 24 to about 96 hours in the presence of at least one nutrient.

79. A method according to Claim 78 wherein said nutrient is selected from the group consisting of yeast extract, diammoniumphosphate, peptone, biotin, thiamin, folic acid, a water soluble vitamin, a fat soluble vitamin, vitamin A, vitamin B complex, vitamin D, vitamin E, vitamin K, vitamin B1, vitamin B2, vitamin B5, vitamin B6, vitamin B12, vitamin B15, and a vitamin.